



Energy Conversion Devices Derived from Novel Electroactive Materials

Newly developed actuators, sensors, and energy harvesting devices using boron nitride nanotubes (BNNTs) and BNNT polymer composites

NASA Langley, Jefferson Lab, and the National Institute of Aerospace have jointly developed new BNNT-based materials with desirable piezoelectric and electrostrictive properties. BNNTs are a direct analog of carbon nanotubes, with superior properties for many applications. They are as strong as carbon nanotubes (within a few percentage points) and are good thermal conductors. The newly developed materials have desirable electroactive characteristics, which make them suitable for use in electromechanical energy conversion devices. The novel materials developed in this joint collaboration are highly flexible, mechanically robust, and thermally stable, all desirable features for electromechanical energy conversion devices, such as sensors, actuators, and energy harvesting devices.

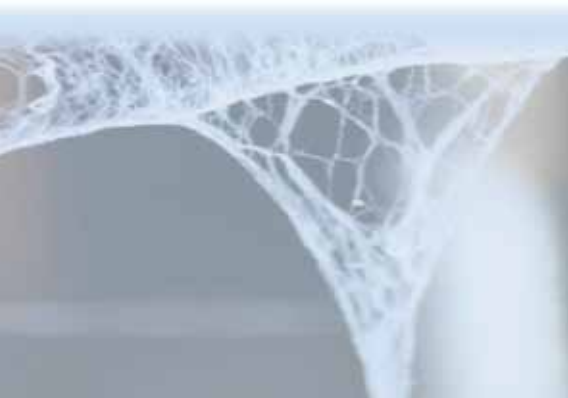
Benefits

- Flexible and lightweight
- Mechanically robust – high strength and modulus
- Resistance to degradation at high temperatures (up to $\sim 800^{\circ}\text{C}$ in air)
- Radiation shielding
- Piezoelectric capabilities (expected piezoelectric constant for BNNT is $0.25\text{--}0.4\text{ C/m}^2$, twice that of polyvinylidene fluoride [PVDF], the best piezoelectric polymer on the market)
- Thermally stable
- High performance and multifunctional

partnership opportunity



The Technology Gateway



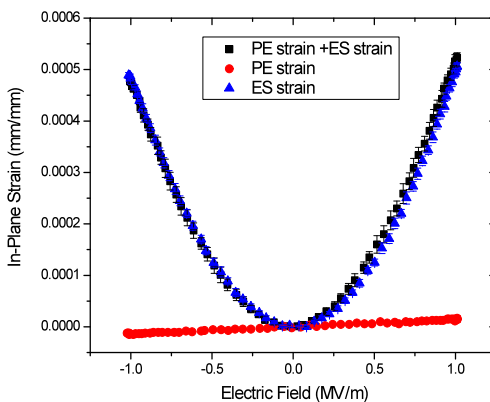
The Technology

This new technology can be used as high performance sensors and actuators for aerospace and automotive applications, such as for future aerospace vehicles and structures. The development of future aerospace vehicles requires lightweight, flexible, mechanically robust, thermally stable, multifunctional materials that can serve as reliable sensors, actuators, and energy harvesting devices. Conventional piezoelectric ceramic powders, such as lead zirconate titanates (Perovskite PZT), have been used with a polymer matrix to create flexible piezoelectric polymer composites. Their heavy weight, brittleness, and toxicity, however, have limited their use in aerospace applications to very low loading levels, and their effectiveness as flexible sensors and actuators has been less than ideal. These BNNT-based materials have proven to be highly flexible, mechanically robust, and thermally stable, all desirable features for electromechanical energy conversion devices.

Applications

- Electromechanical energy conversion devices – sensors/actuators, transducers, sonars, and energy harvesters
- Optical devices – optical switches and modulators
- Biomedical – medical devices, prosthetics, and artificial muscles
- Vibration and noise control

In addition, the piezoelectric function of the BNNT-based materials can harvest energy during the flight missions and driving conditions from various mechanical stimuli of astronaut/pilot/driver suits, noise, and vibrations of vehicles. By providing auxiliary power for electronic devices and health monitoring sensors and actuators, long-term flight missions can be safer and prolonged. These novel piezoelectric energy-harvesting devices can be used in extreme environments because of BNNTs' high thermal stability against oxidation (up to 800°C) and their excellent radiation-shielding capability against neutron and UV radiations.



Electric field induced strain of BNNT composites



Prototype BNNT-based flexible electromechanical conversion film

For More Information

If your company is interested in licensing or joint development opportunities associated with this technology, or if you would like additional information on partnering, please contact:

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